

Orbital Debris Collection Experiment (ODC):

Progress Report

(Jan. - June, 1998)

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OUTLINE:

BACK GROUND

Instrument and Objectives

Early Surveys and Activities

PROGRESS (since January):

Optical Survey: **Tracks > 0.5 mm on ≈ 30% of surface**
 Track Morphology and Orientation

Compositional Analysis: **Systematic survey (SEM-EDS)**
 Select Tracks/Impactors (SEM-EDS)
 Cosmic Dust Grains (SEM-TEM)

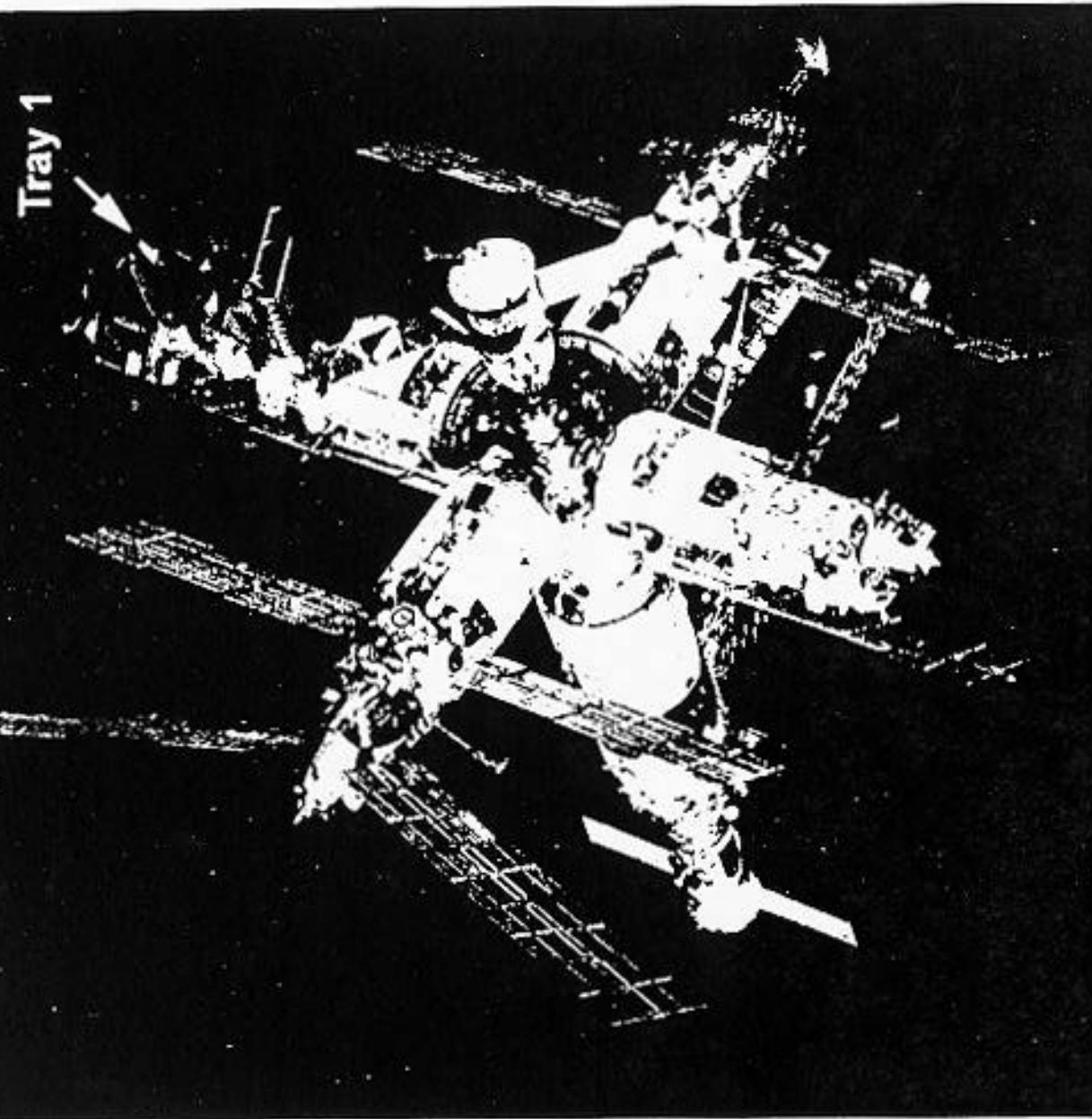
Swarm Event: **Natural Impactor Fragments**

Upcoming Activities/Plans:

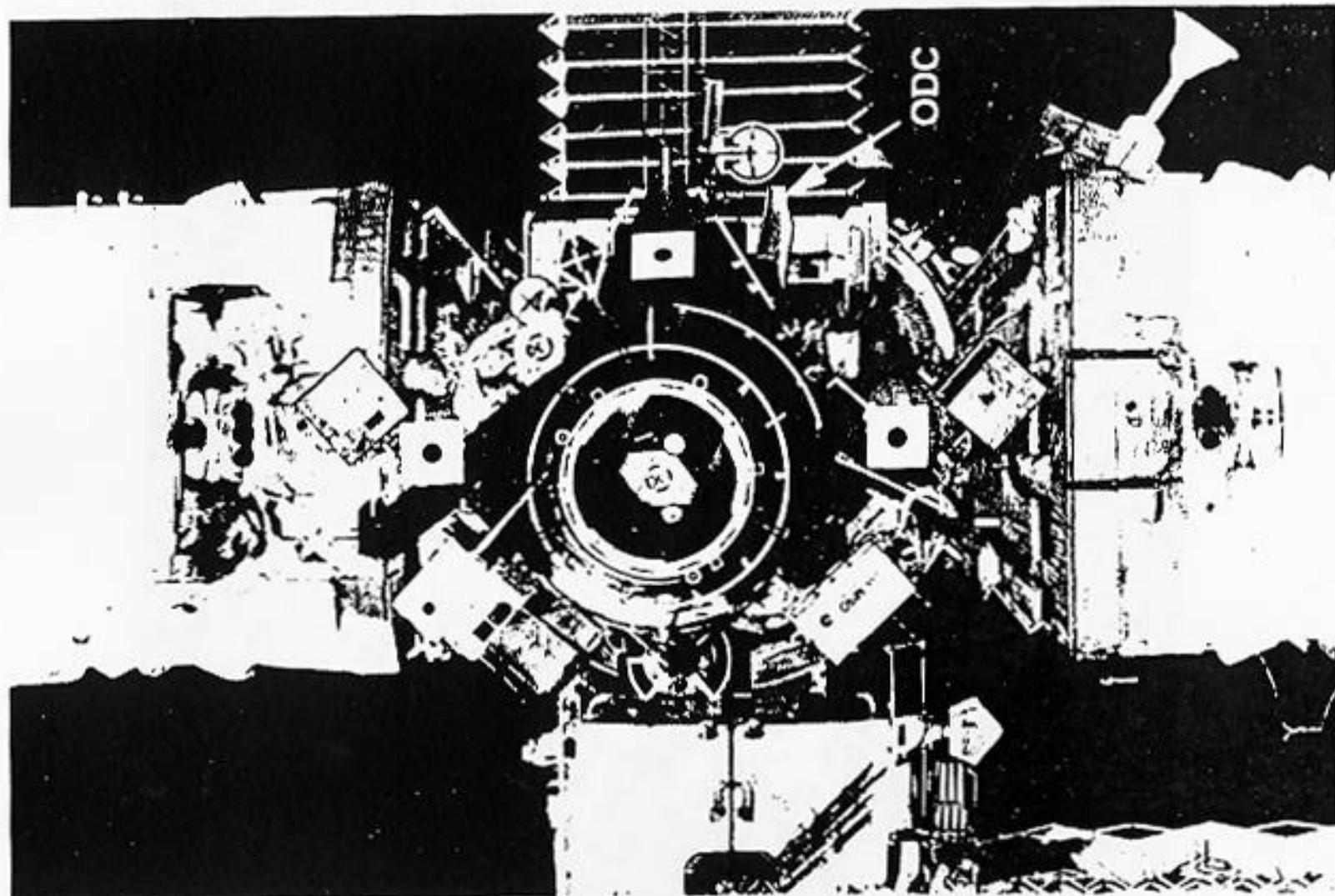
Continued Analysis/ 1 Year Report/ New methods
Active Experiment Concepts for Future SEE Instruments

INSTRUMENT OVERVIEW:

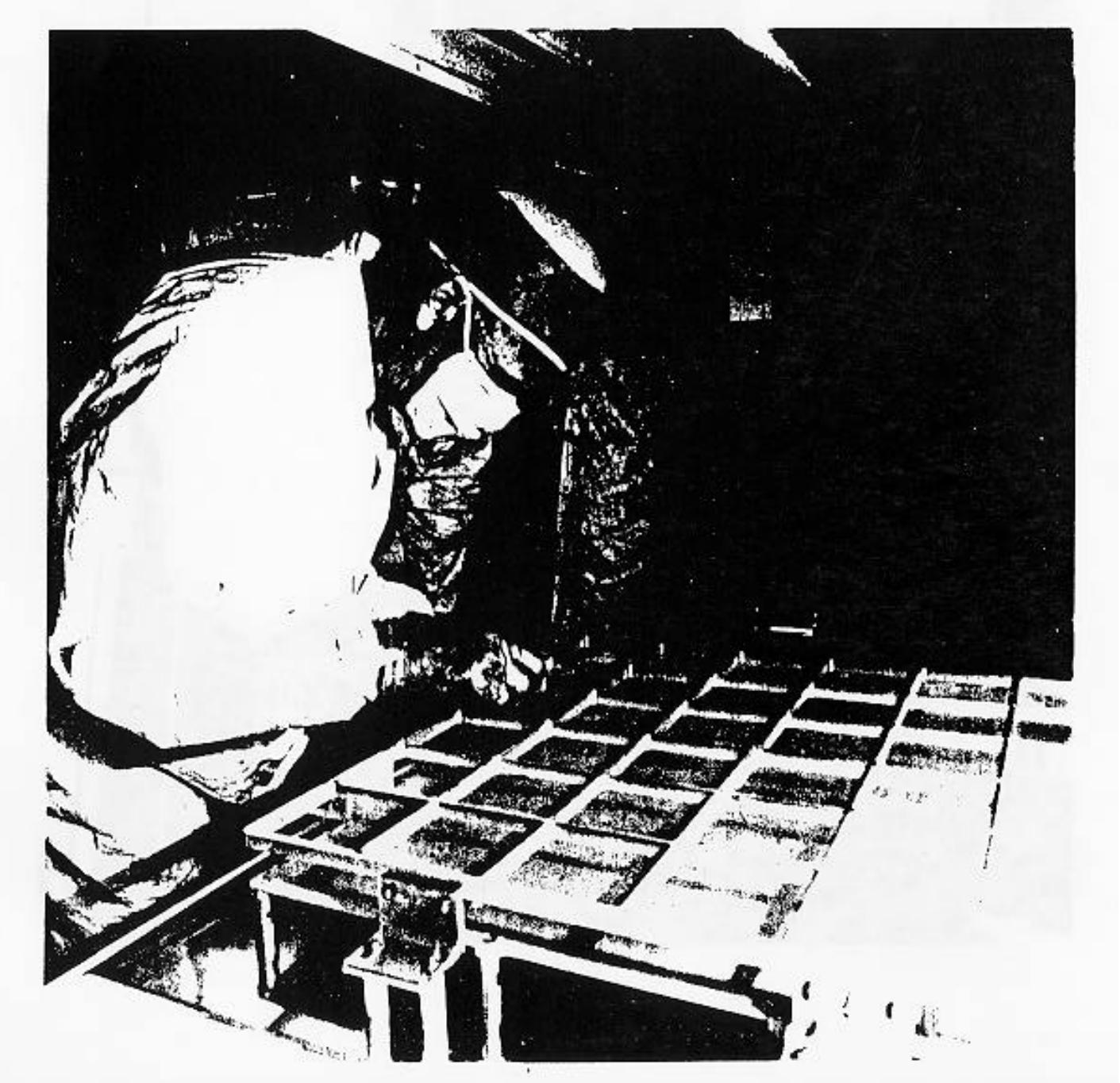
Objective:	Trap unmelted fragments/residues of hypervelocity particles and evaluate their sources and origins from detailed mineralogic and compositional analysis in the terrestrial laboratory.
Collector Material:	<p>SiO₂ Aerogel</p> <p>Density: 0.02 g/cm³</p> <p>Individual Tiles: 10 X 10 X 1 cm (provided by JPL)</p> <p>Extensive pre-flight impact tests, yet not well "calibrated"</p> <p>Recovered mass some 0.5-0.7 m₀ at 6 km/s</p> <p>No substantial dependence on velocity from 3-7 km/s</p> <p>Good preservation of</p>
Collector Arrays :	<p>2 Trays, each containing 36 tiles (0.35 m² per tray)</p> <p>Tray 1 : general forward direction</p> <p>Tray 2 : general rearward facing</p> <p style="padding-left: 40px;">Detailed exposure geometry TBD</p> <p>Aerogel survived all operations in pristine condition</p> <p>All collectors harvested and described macroscopically</p> <p>All hardware preserved for reflight, save aerogel</p>



Tray 1







921917 195909 AEROCFI 1C84 P15

b

471817 104824 AEROGEL 1405 004

2011-11293 AEROGEL 1F04 11.3.3

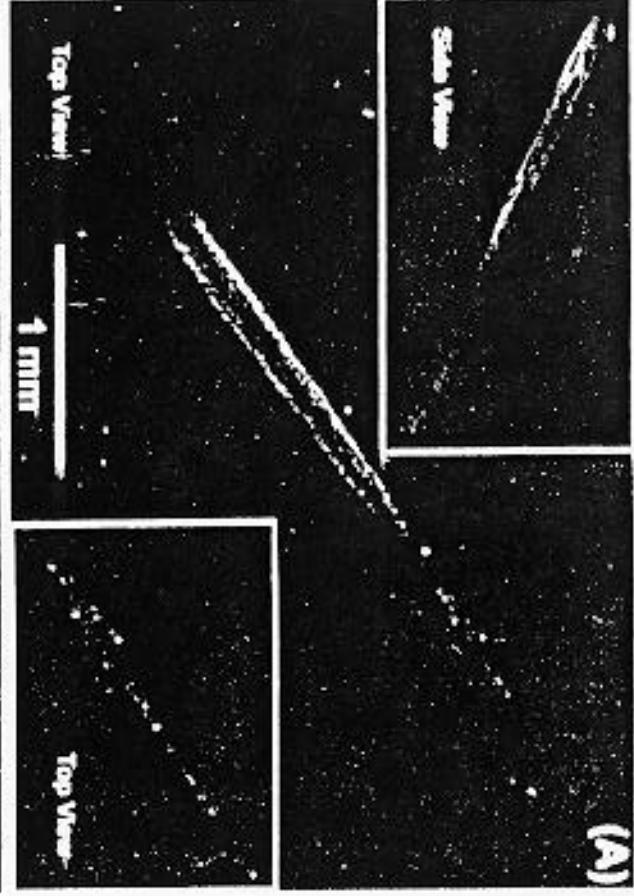
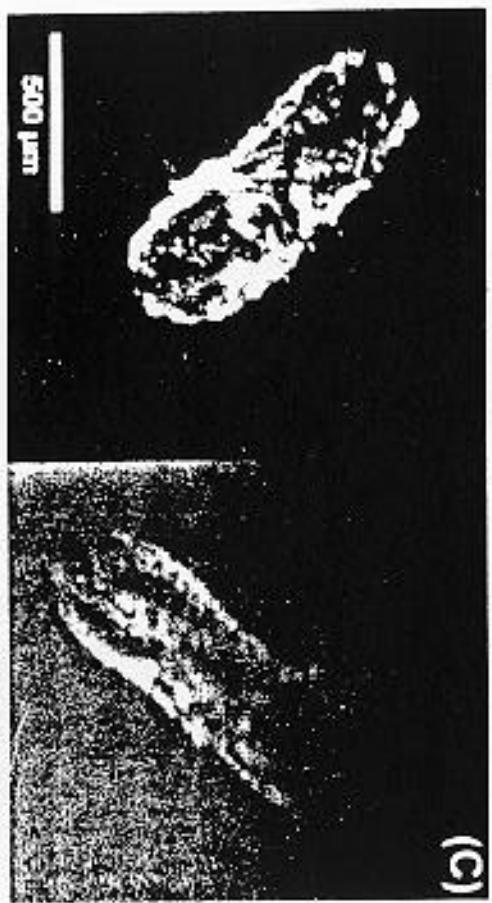
1A01-9
Transmitted Light

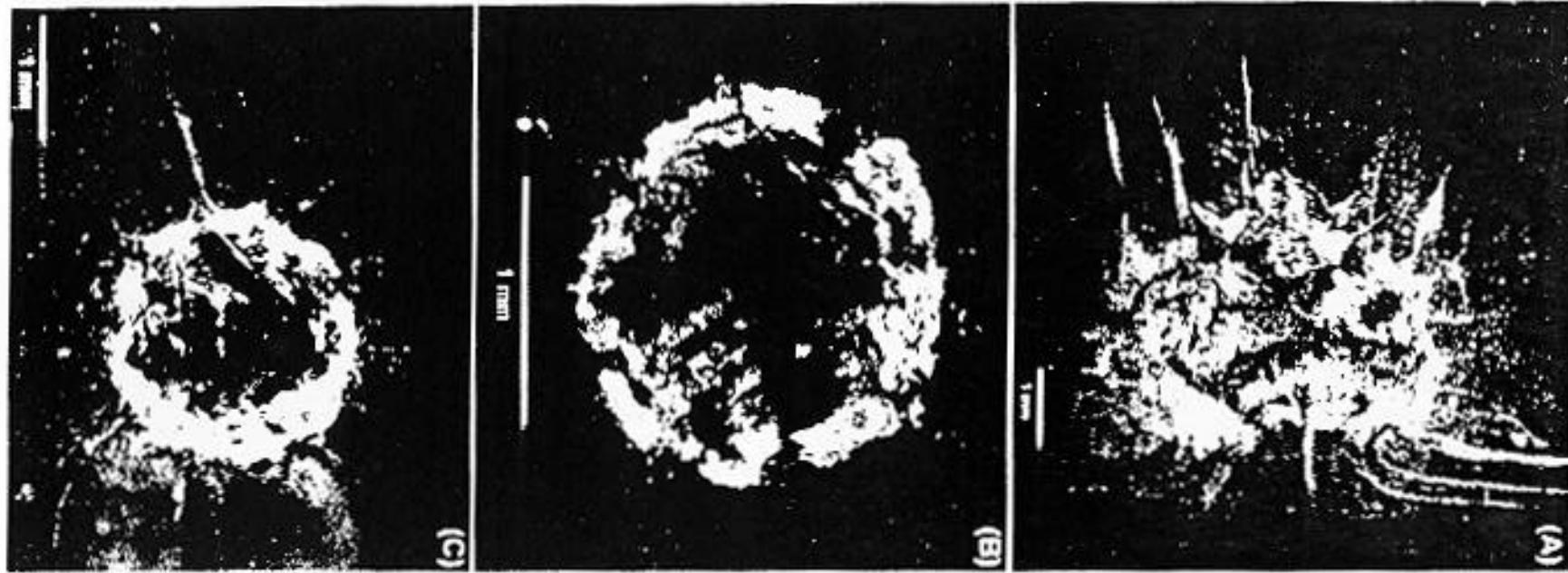
500 μm

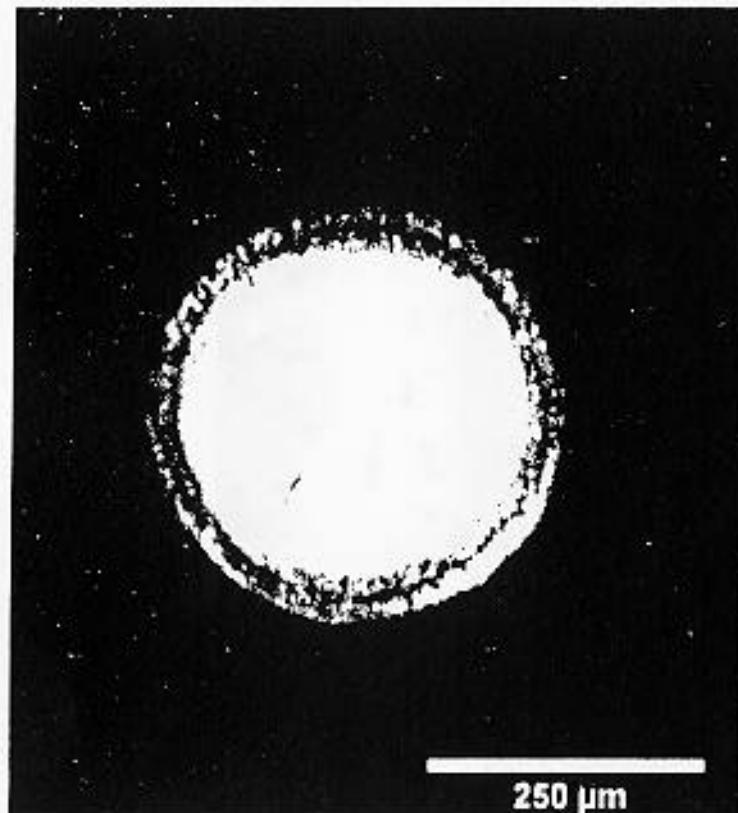
Reflected

Transmitted

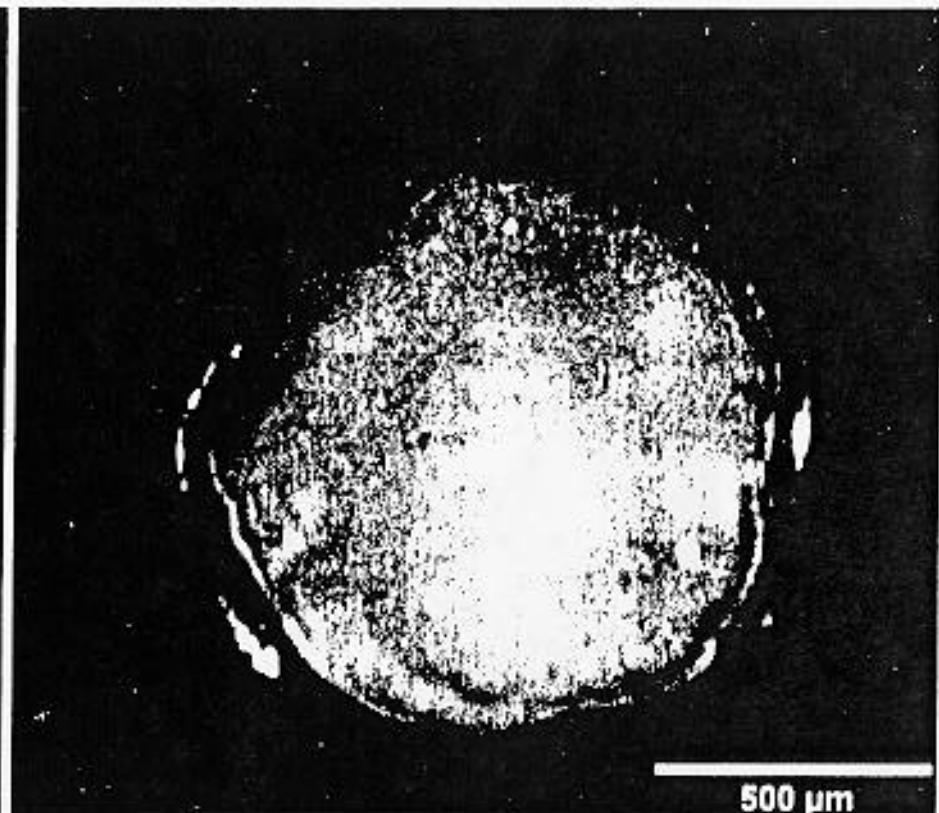
100 μm



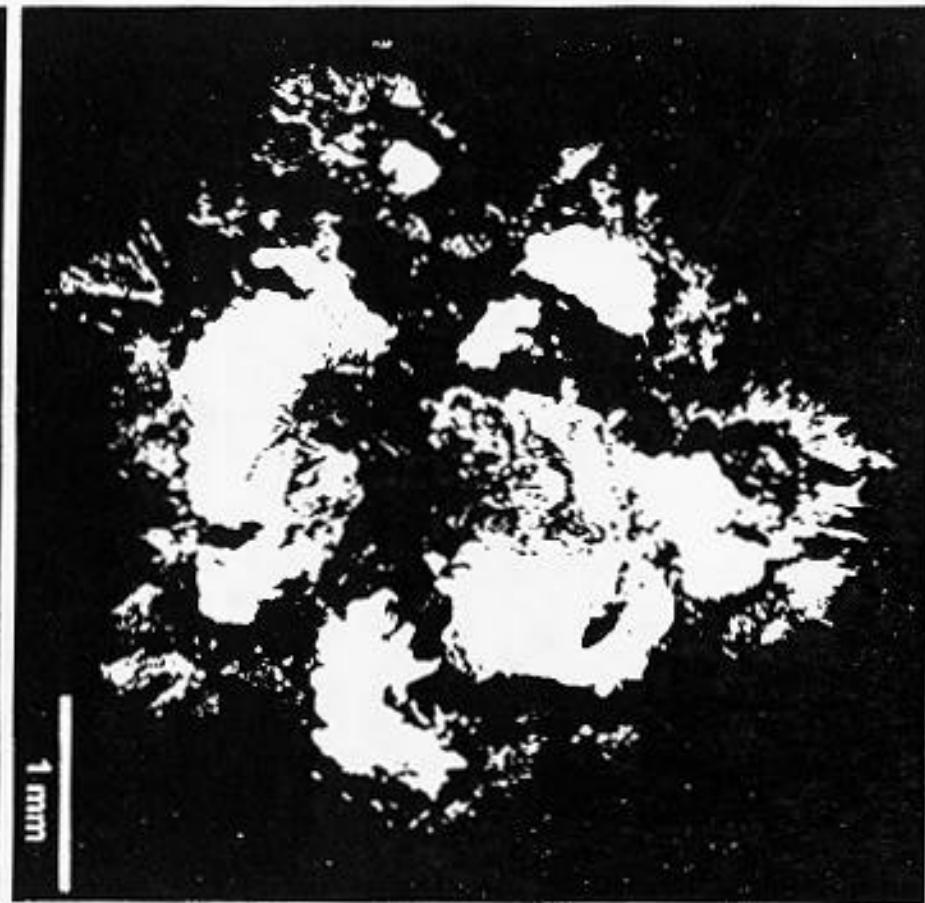




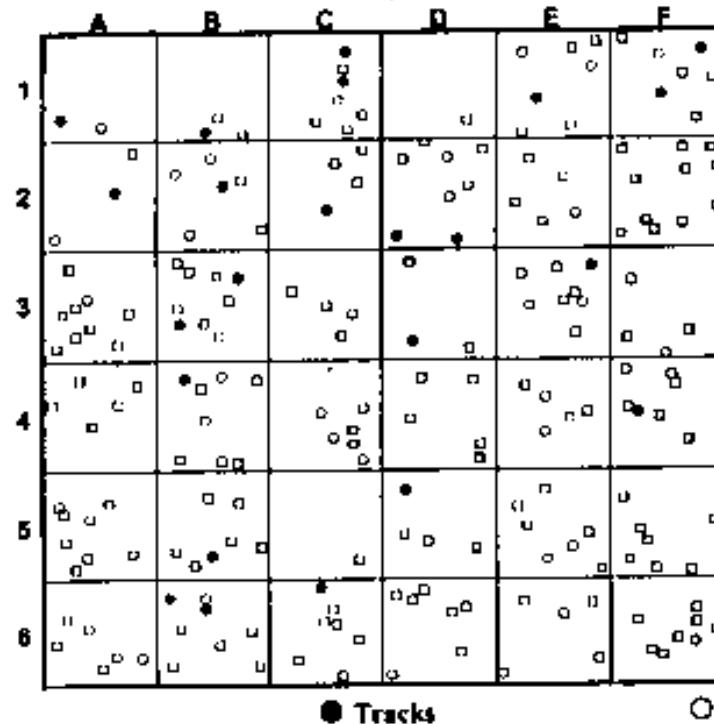
250 μm



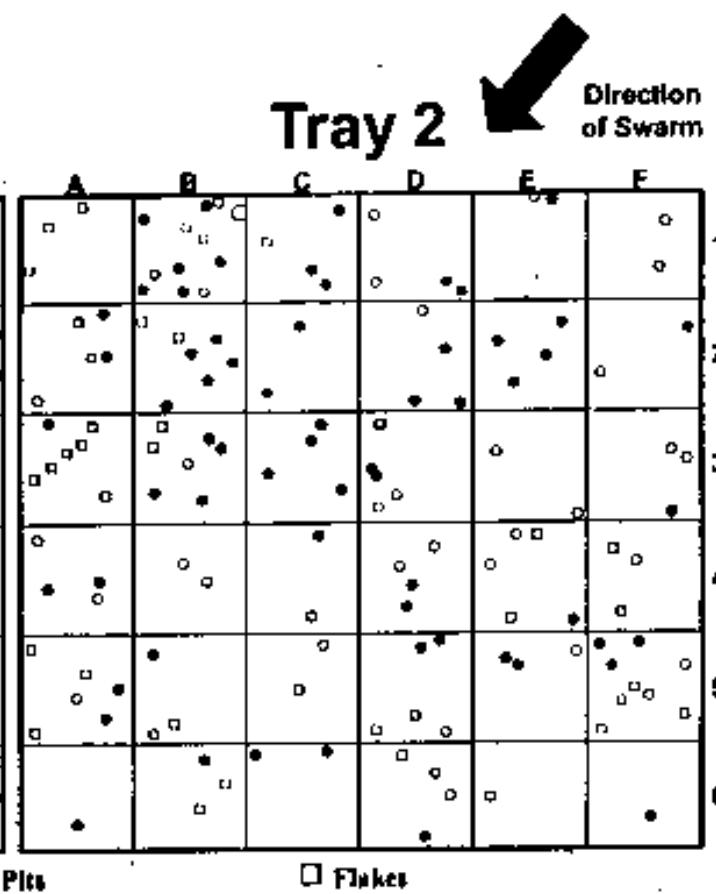
500 μm

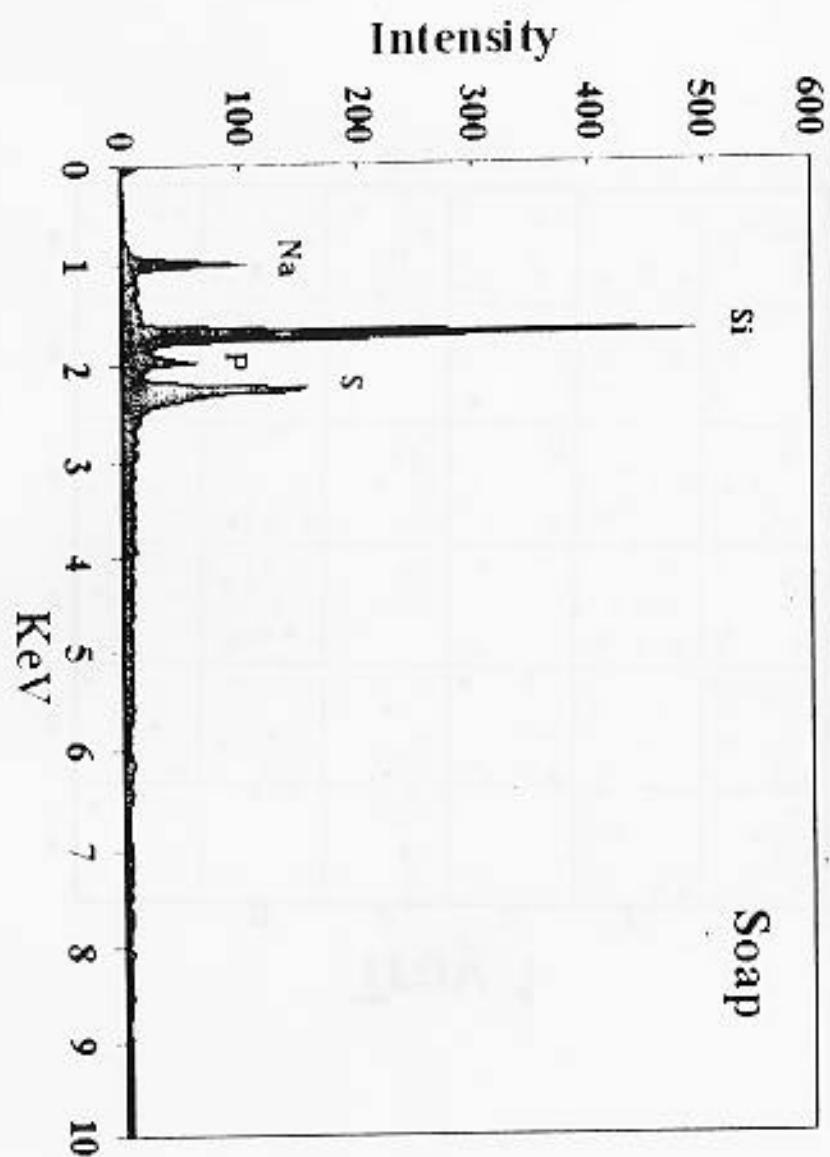


Tray 1



Tray 2



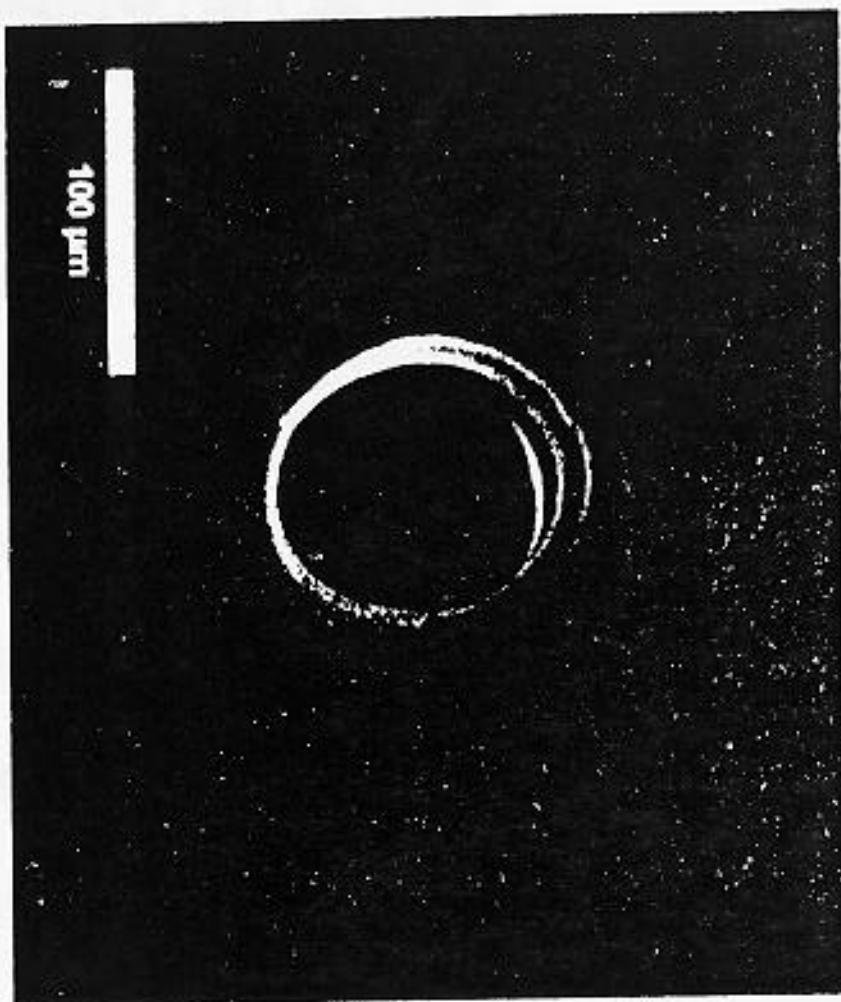
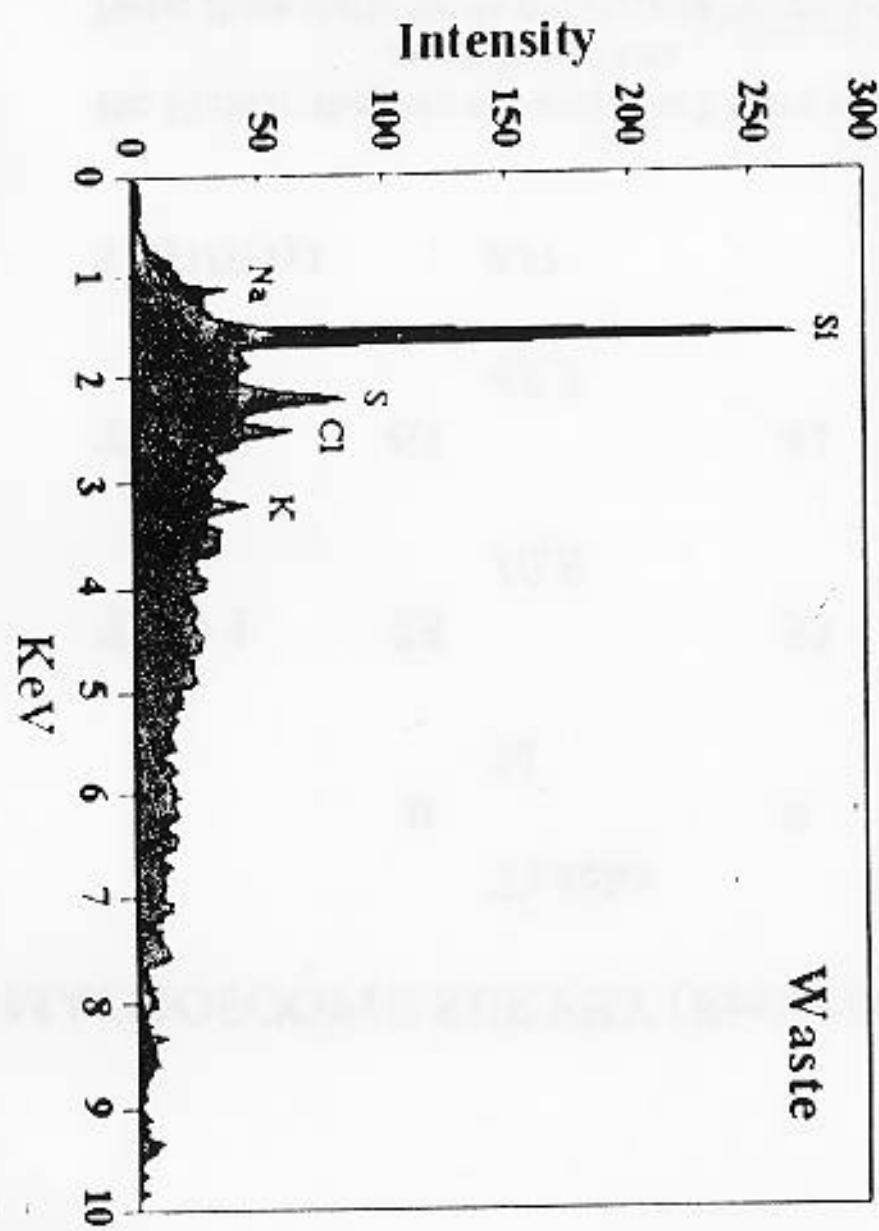


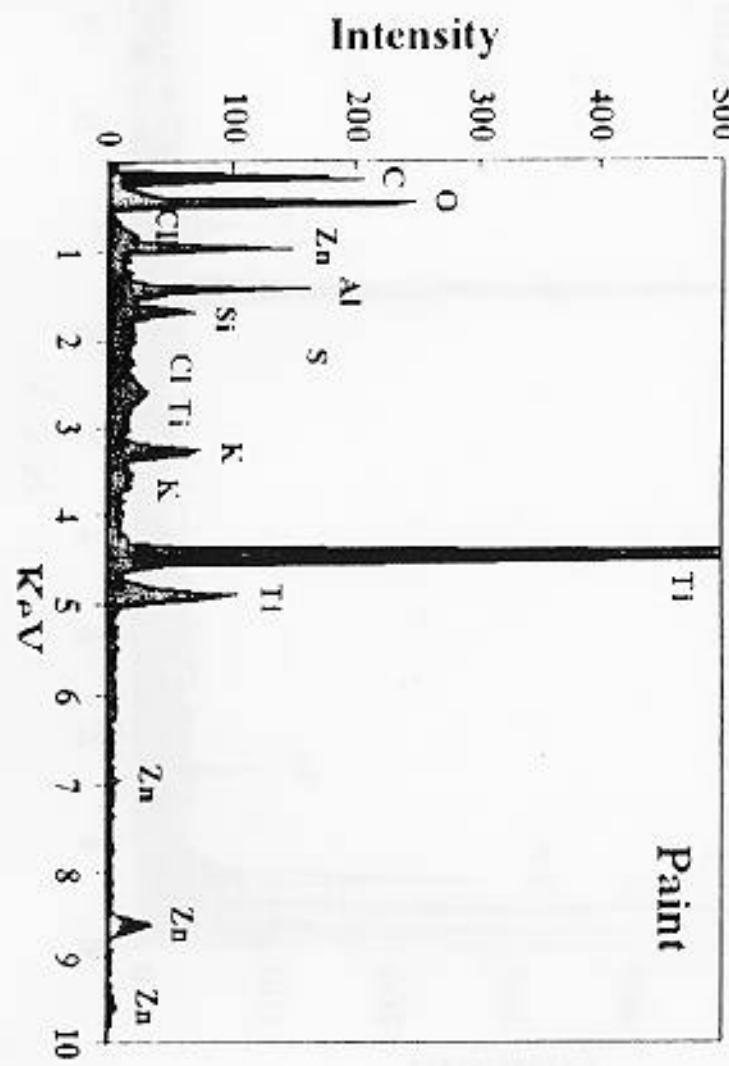
MACROSCOPIC SURVEY (Features > 1 mm)

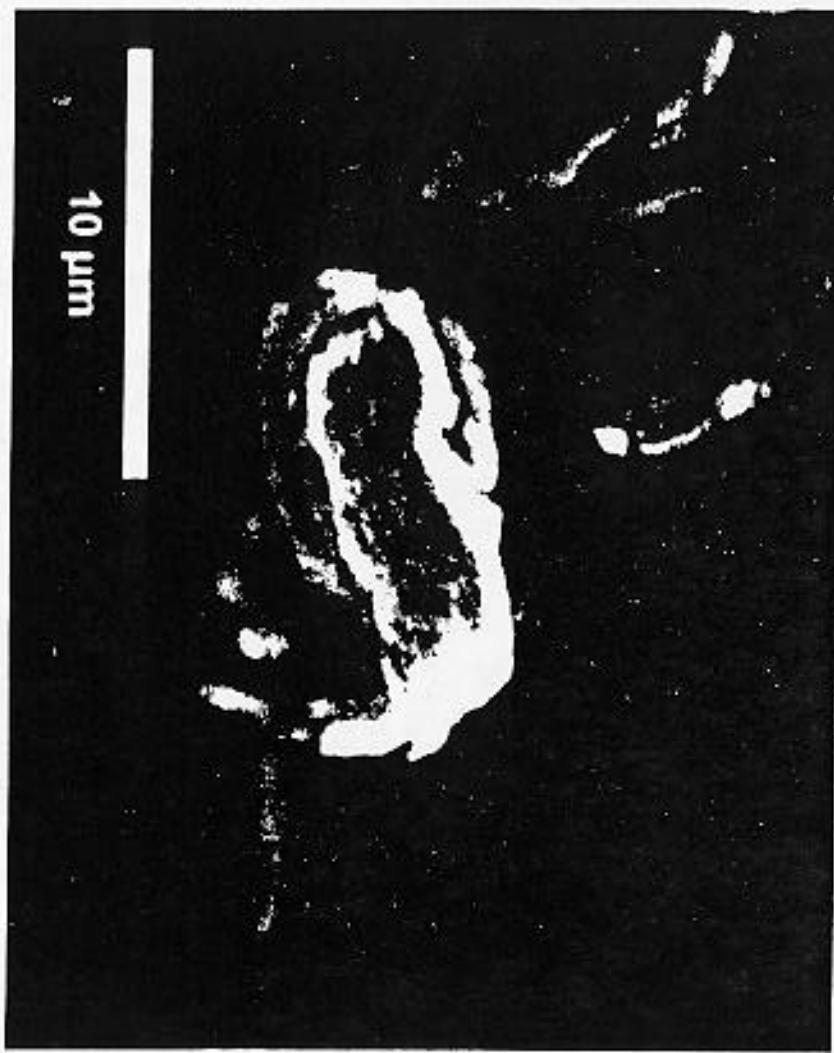
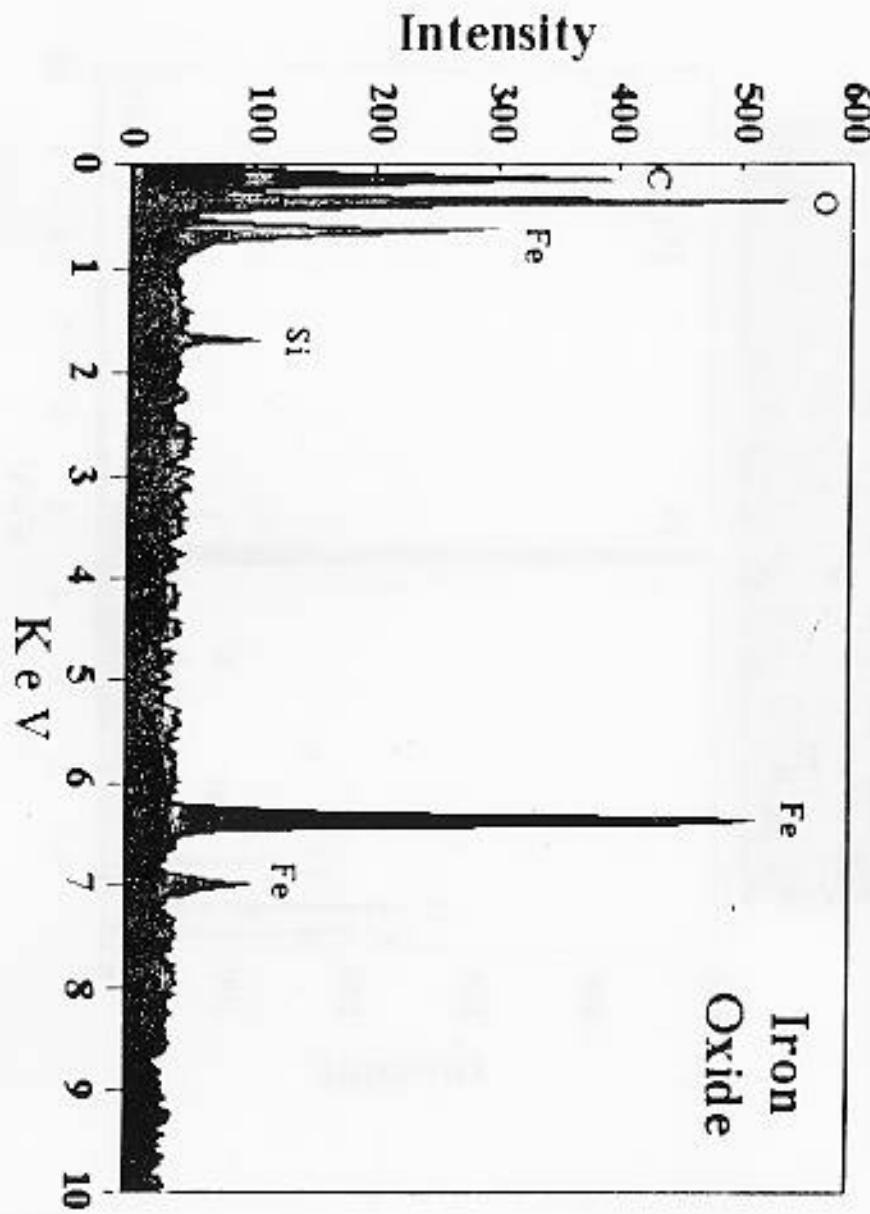
	Tracks		Pits		Flakes		totals
	n	%	n	%	n	%	
Tray 1	23		33		156		212
		<i>10.8</i>		<i>15.6</i>		<i>73.6</i>	
Tray 2	63		41		35		139
		<i>45.3</i>		<i>29.5</i>		<i>25.2</i>	
Tray1/Tray2		0.37		0.30		4.46	

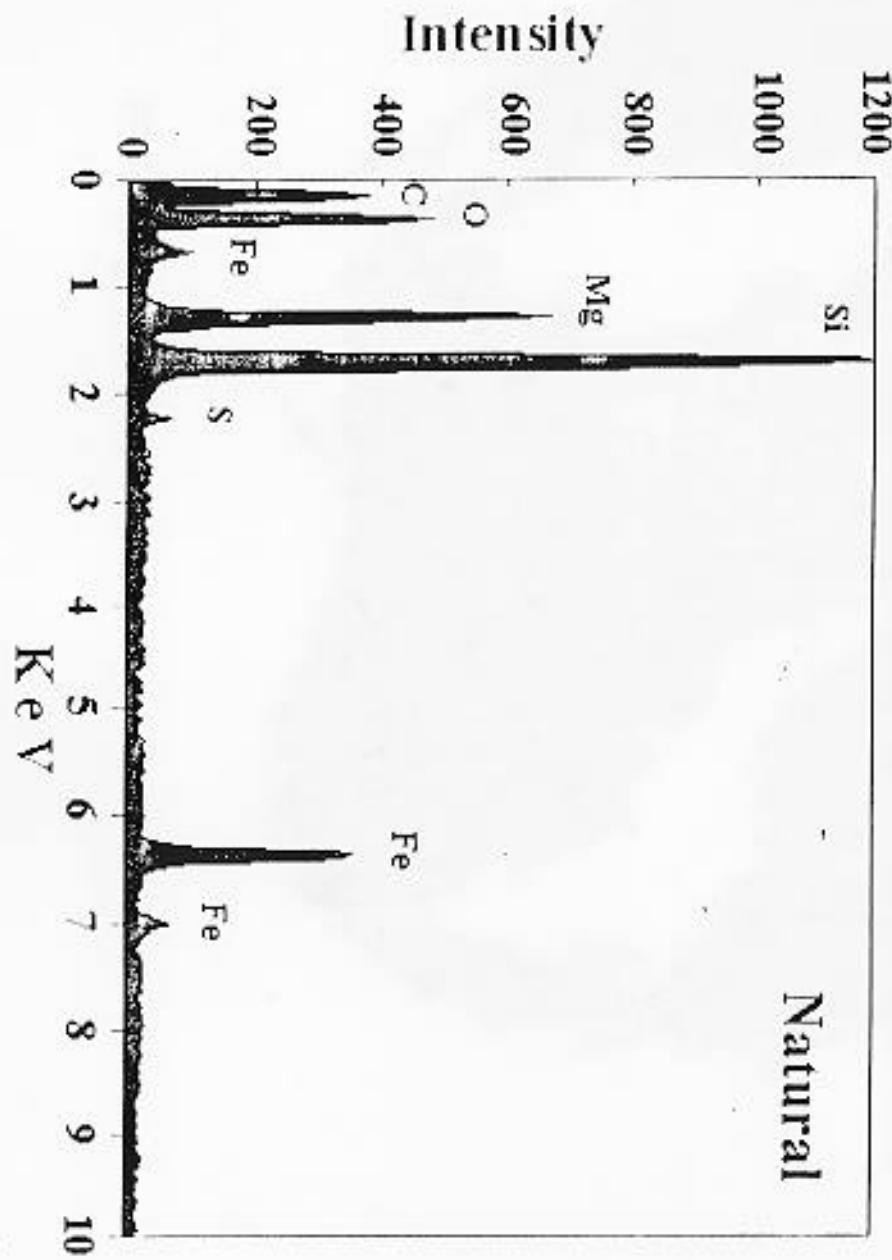
Re. Flakes: they are not only much more abundant on Tray 1, but also of much larger size

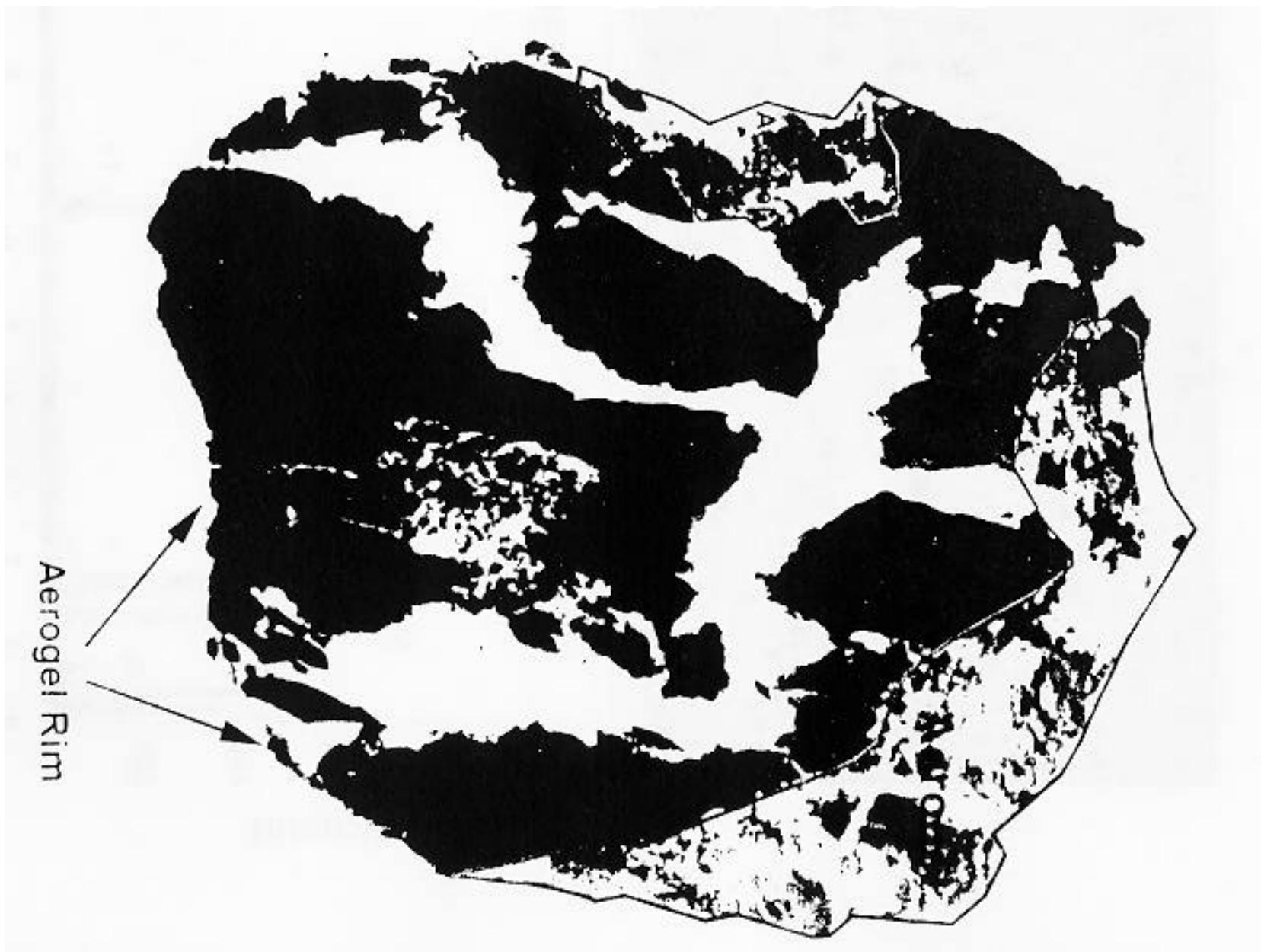
Note: these statistics do not include "swarm-tracks" of which there are hundreds.

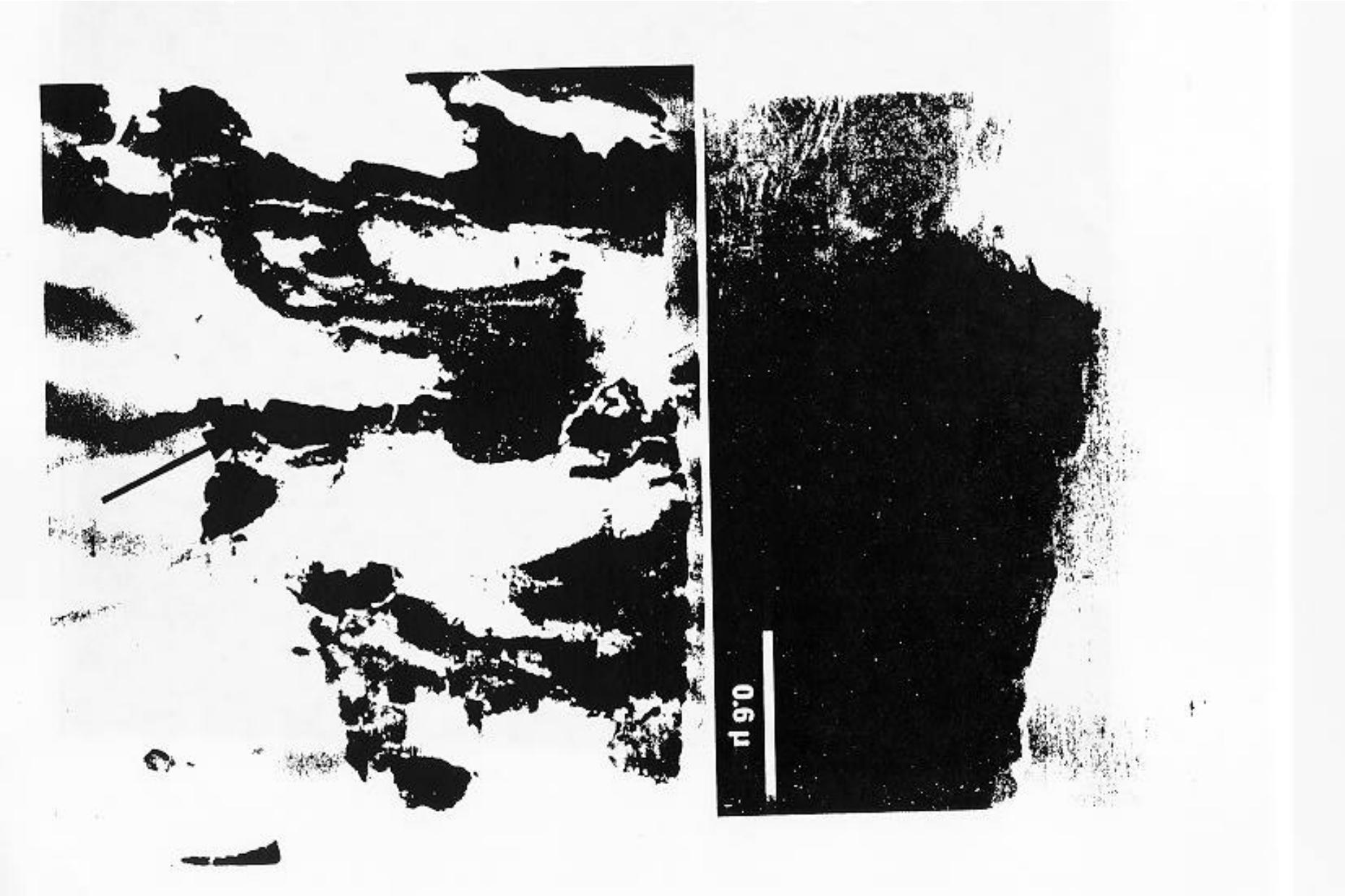






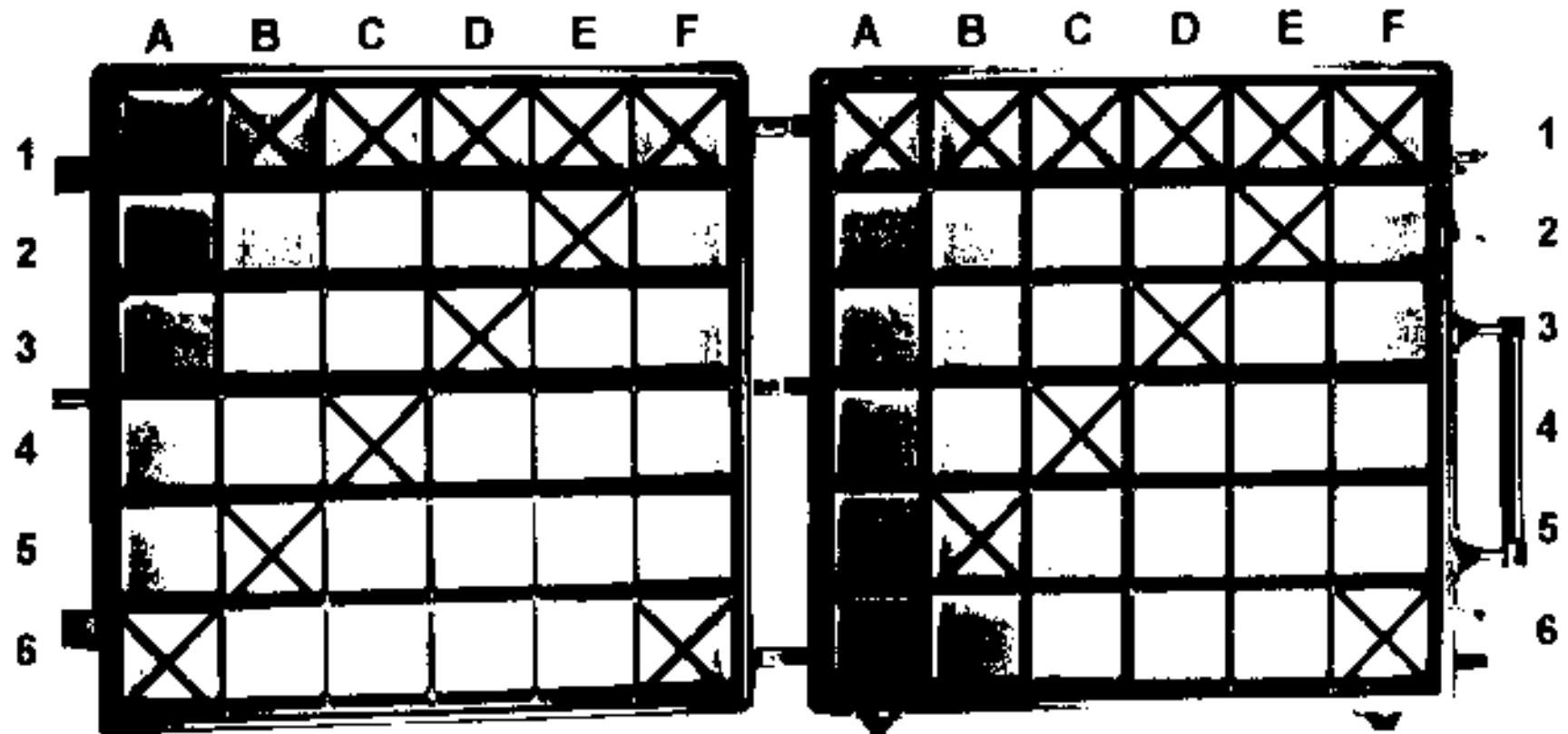




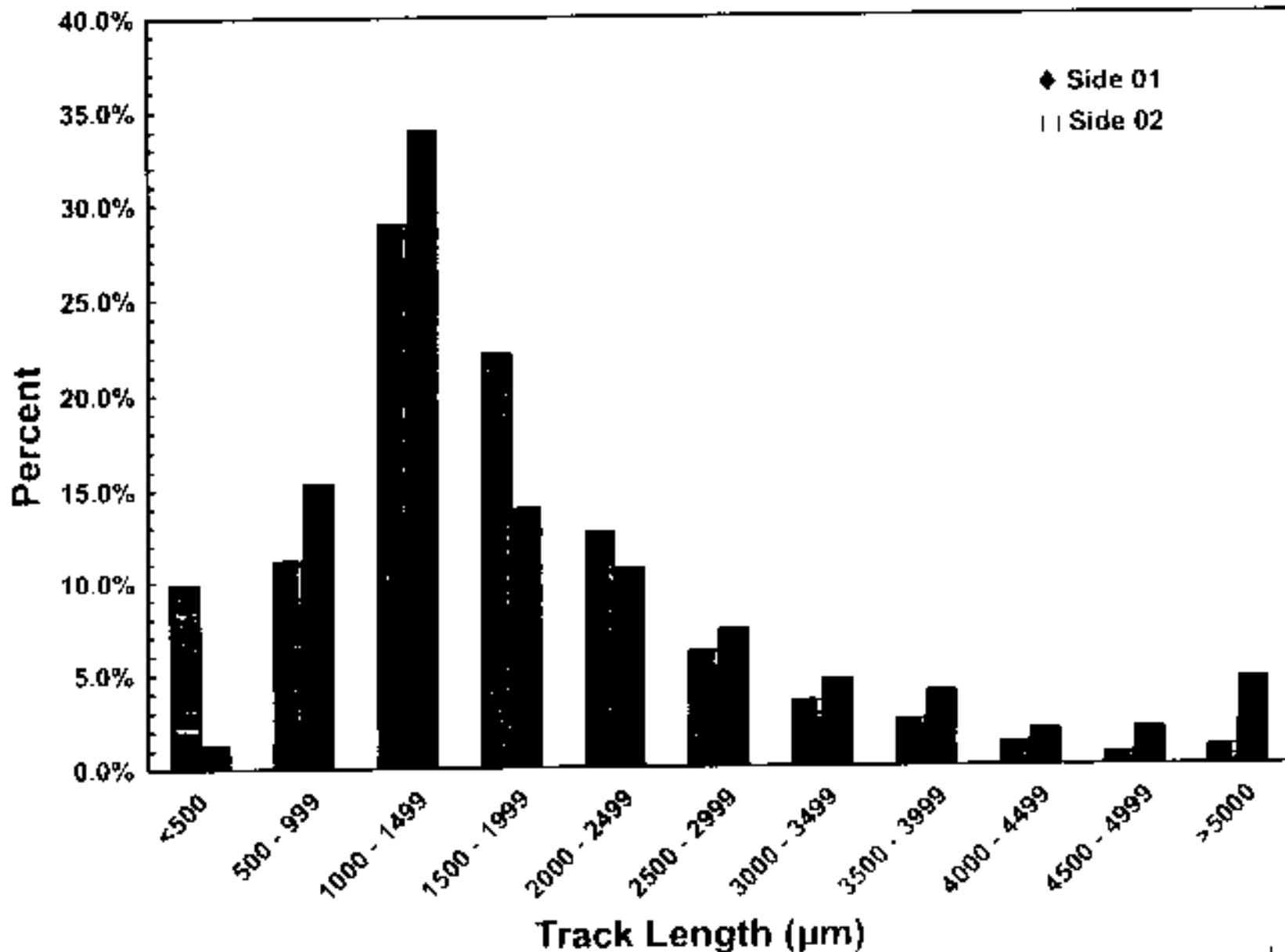




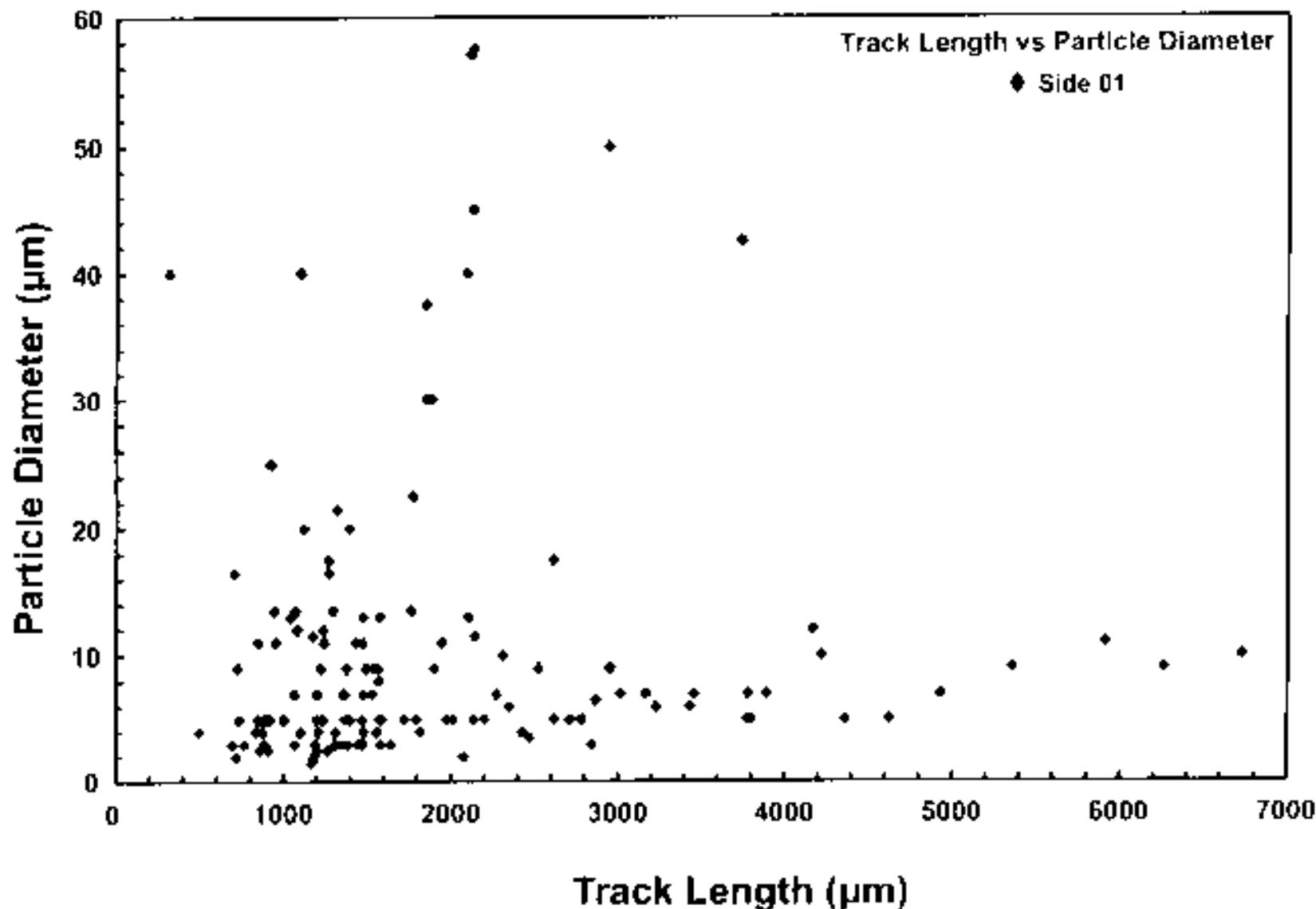
Field of view = 11 mm



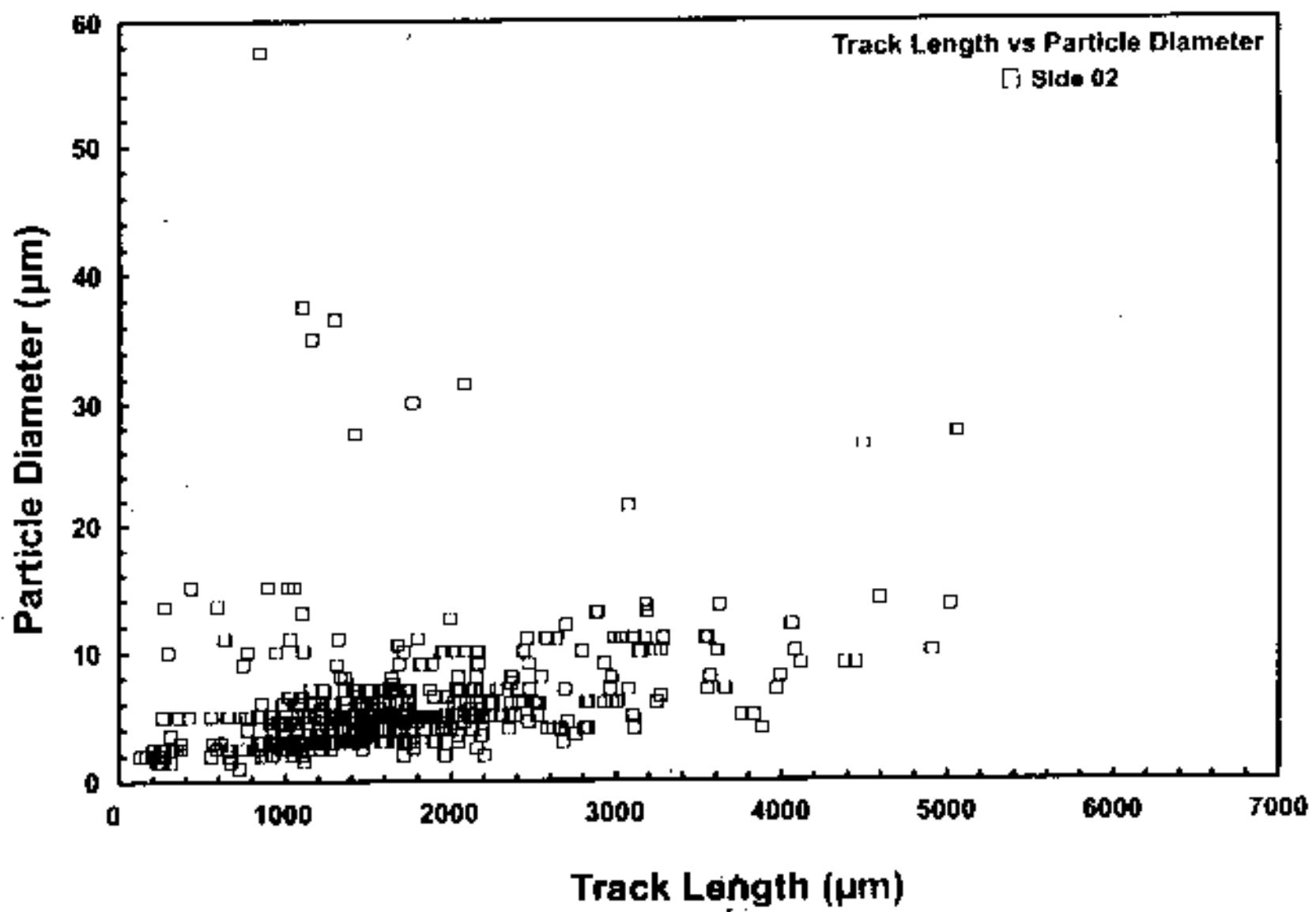
Orbital Debris Collector



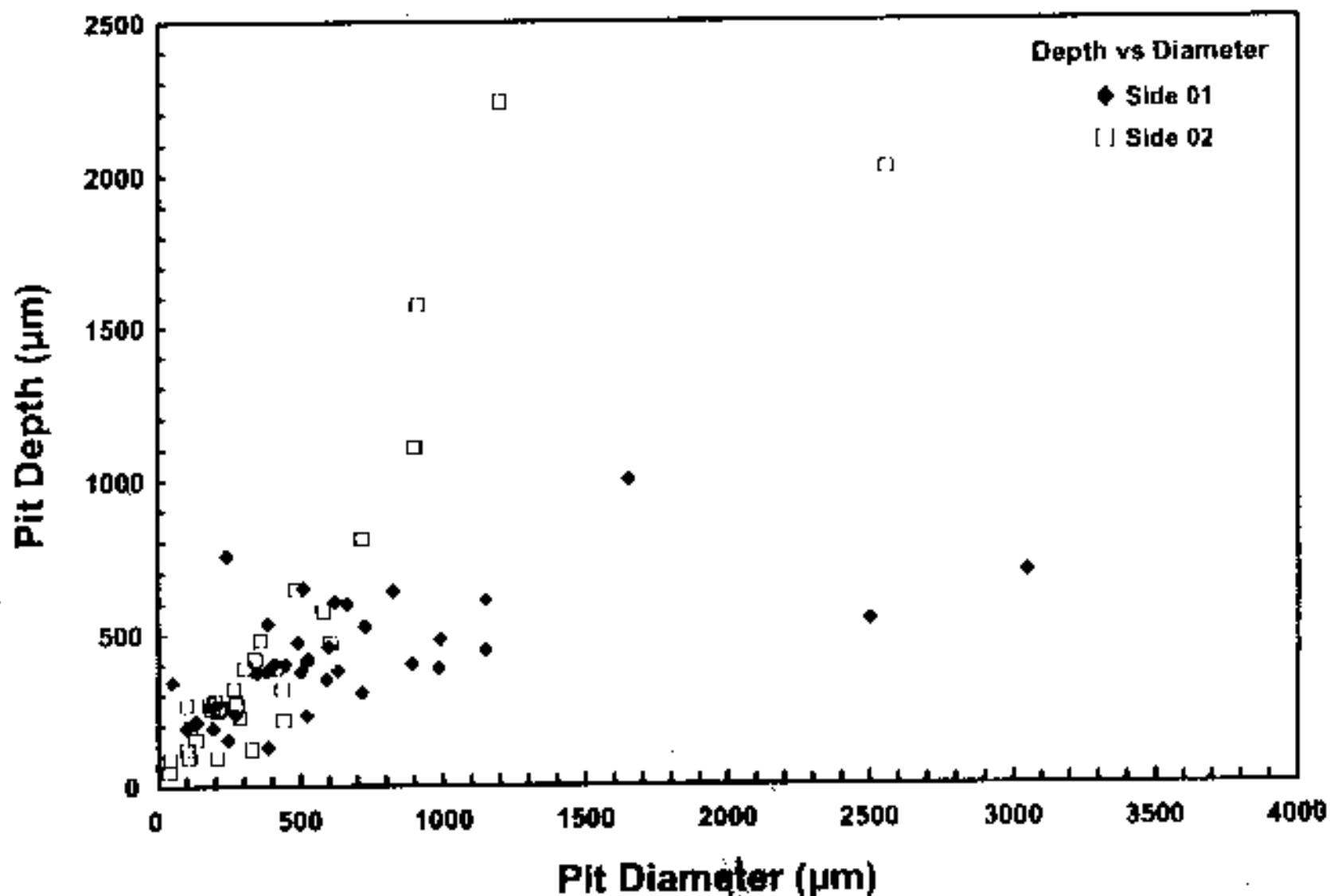
Orbital Debris Collector



Orbital Debris Collector

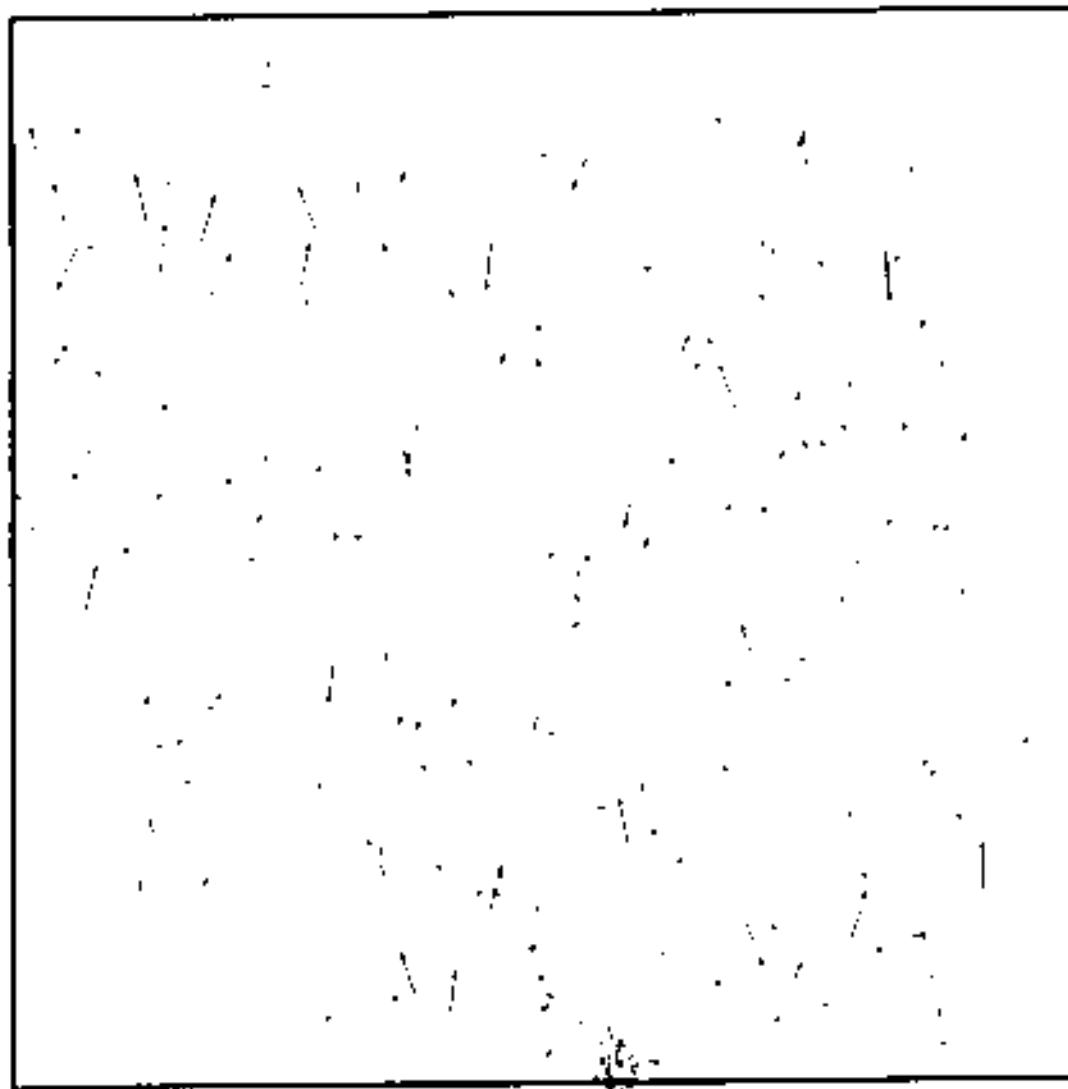


Orbital Debris Collector



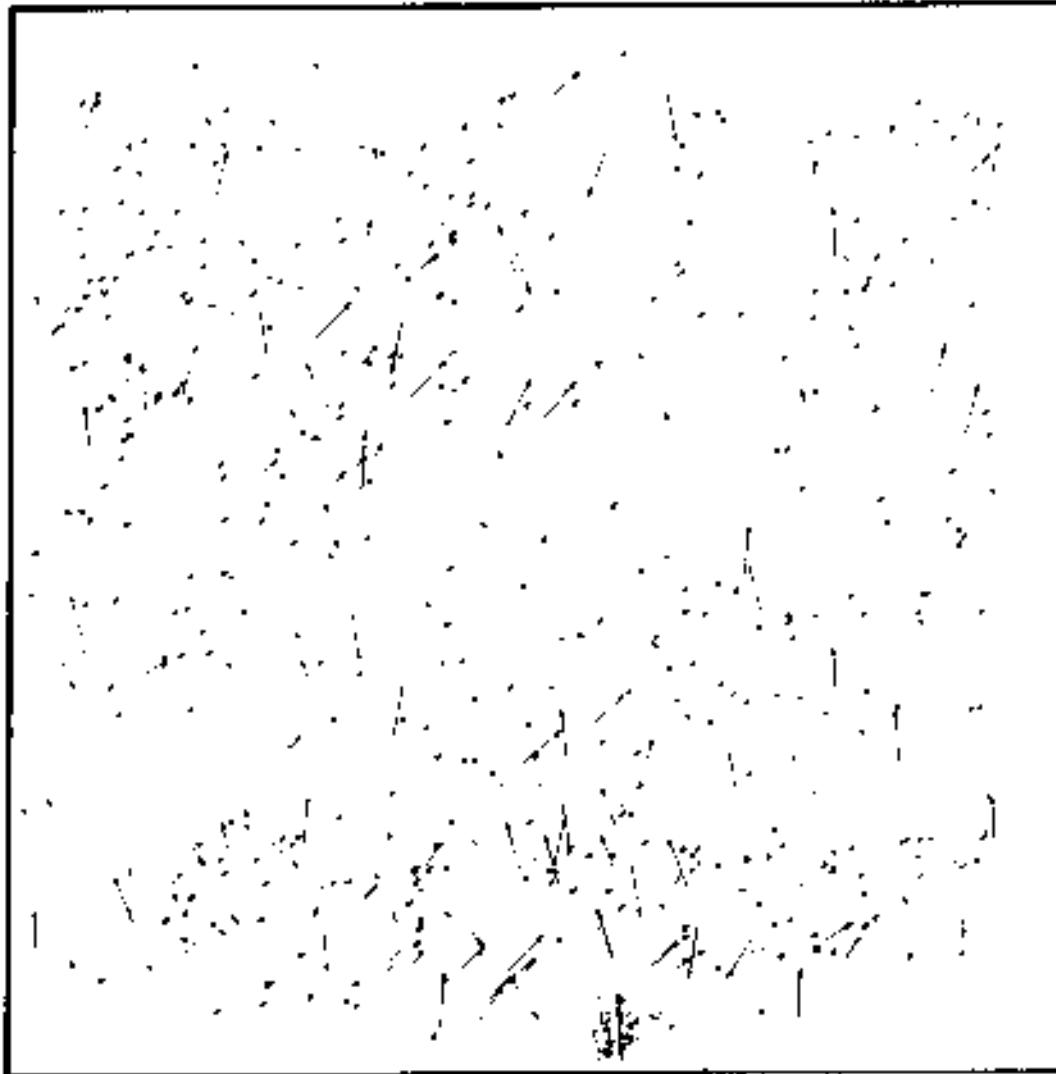
Orbital Debris Collector

Side 01



Orbital Debris Collector

Side 02



Residues Defined in Tile 1AO6 (all features > 1 mm)

Feature # 1		particle lost
Feature # 2	Al, O	Al ₂ O ₃
Feature # 3	Fe, Ni, Cr	Stainless Steel
Feature # 4	Si, Fe, Mg, S	cosmic dust
Feature # 5	Si, Fe, Mg, S, Al, Ni	cosmic dust
Feature # 6	Si, Mg, Fe, Ni	cosmic dust
Feature # 7		track lost/destroyed
Feature # 8	Si, Fe, Mg, S, Ca, Ni	cosmic dust
Feature # 9	Ti, Al, Si, K, Zn	paint
Feature #10	Fe, Ni, S, Si, Mg	cosmic dust
Feature #11	Al	metallic aluminum
Feature #12	Ti, Al, Zn, Si, C, K	paint

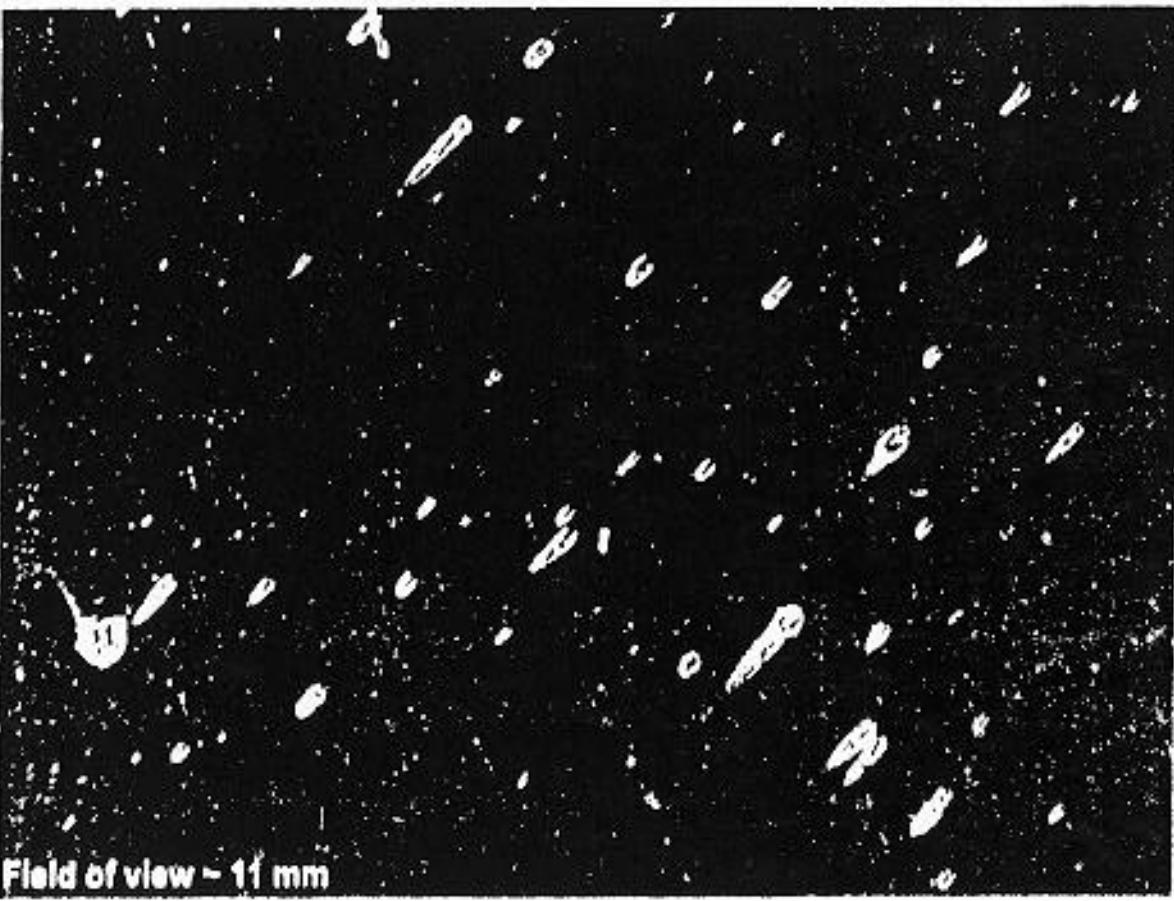
NOTE: This tile contained an additional 6 rather shallow "events" that were not analyzed and which are clearly caused by human waste products
Also, 3 "pits" were observed that did not contain visible residue and that were not analyzed.

Residues Identified in Tile 1CO1

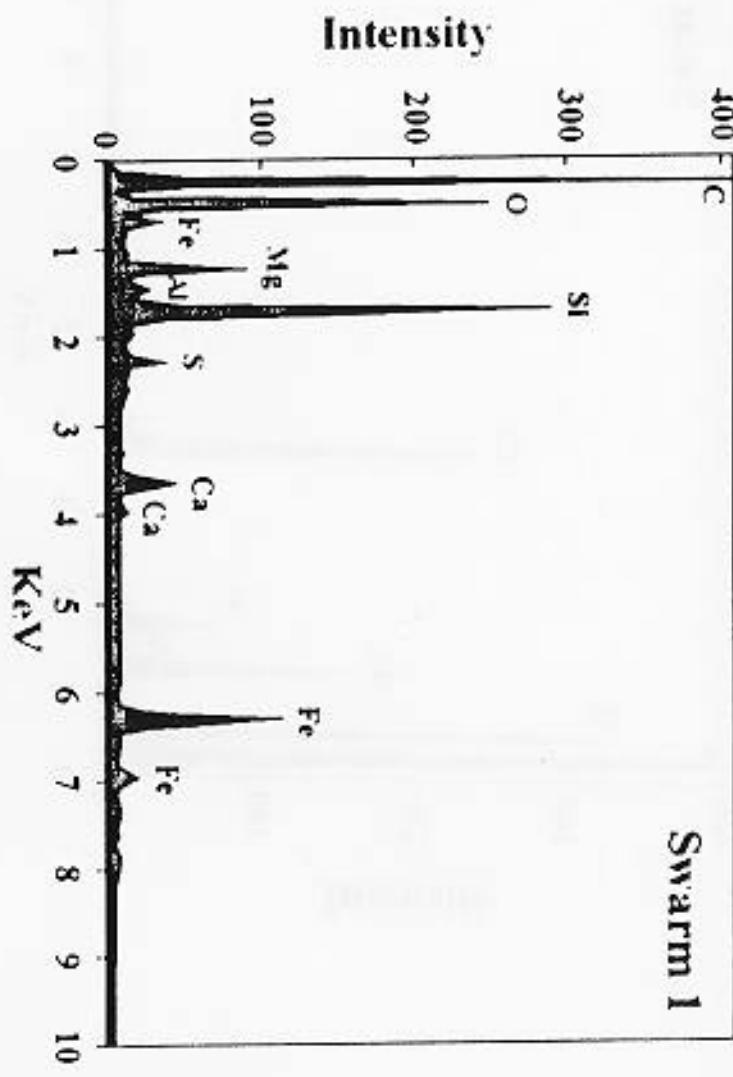
(all features > 1 mm)

Feature # 1	S, P, Na*)	soap
Feature # 2	Na, S, Cl, K	human waste
Feature # 3	S, P, Na	soap
Feature # 4	Tl, Cl, Al, K	paint
Feature # 5	S, P, Na	soap
Feature # 6	Na, S, Cl, K	human waste
Feature # 7	S, P, Na	soap
Feature # 8	Na, S, Cl, K	human waste
Feature # 9	no projectile traces detectable	
Feature # 10	Na, S, Cl, K	human waste
Feature # 11	particle lost during extraction	
Feature # 12	Mg, S, Fe, Ca	meteoritic
Feature # 13	Fe	Fe or FeO (T) ^{3D})

***) Approximate order of concentration**

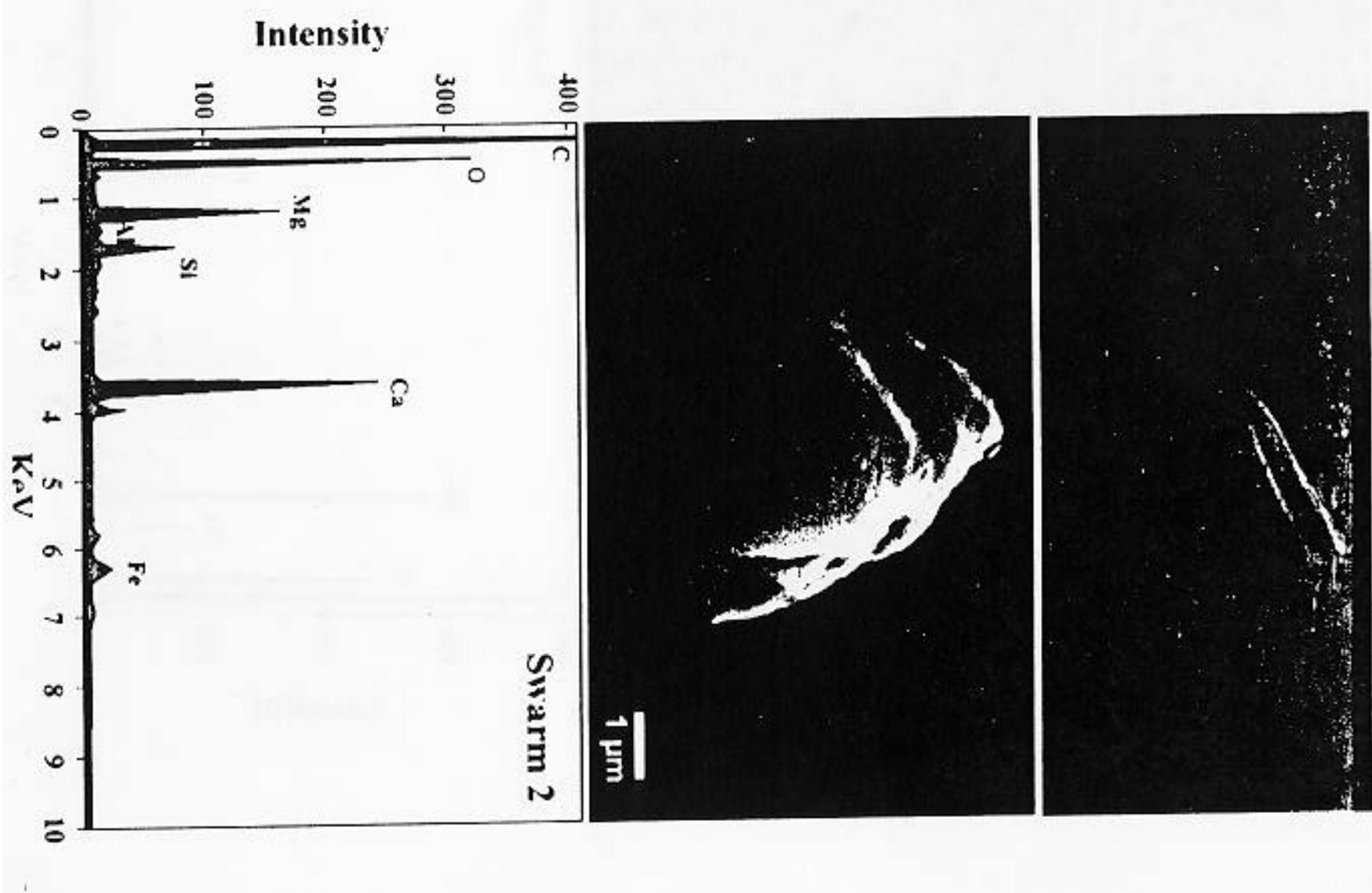


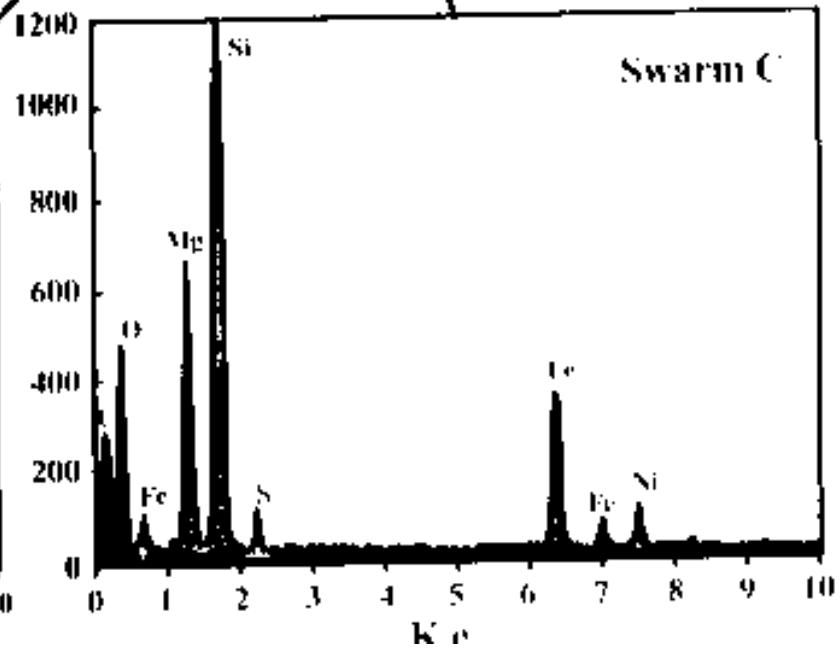
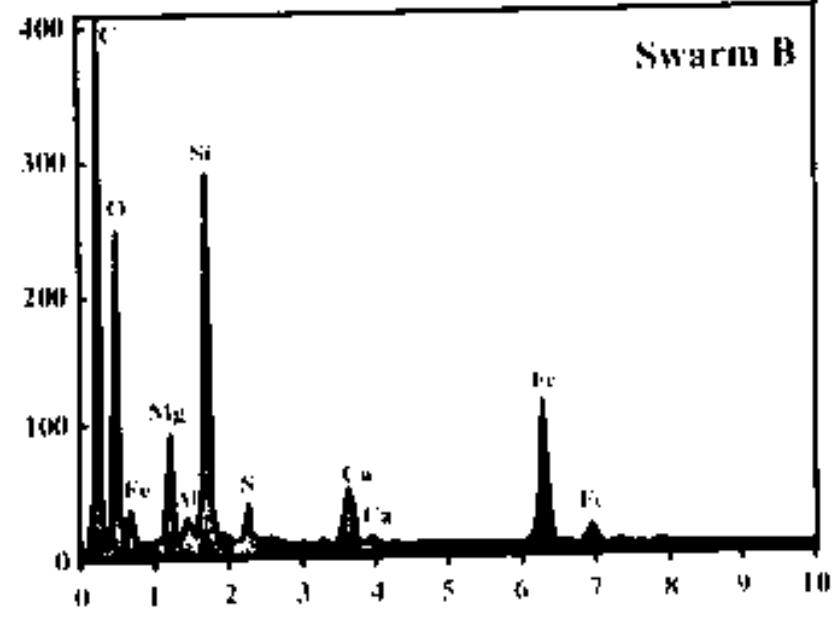
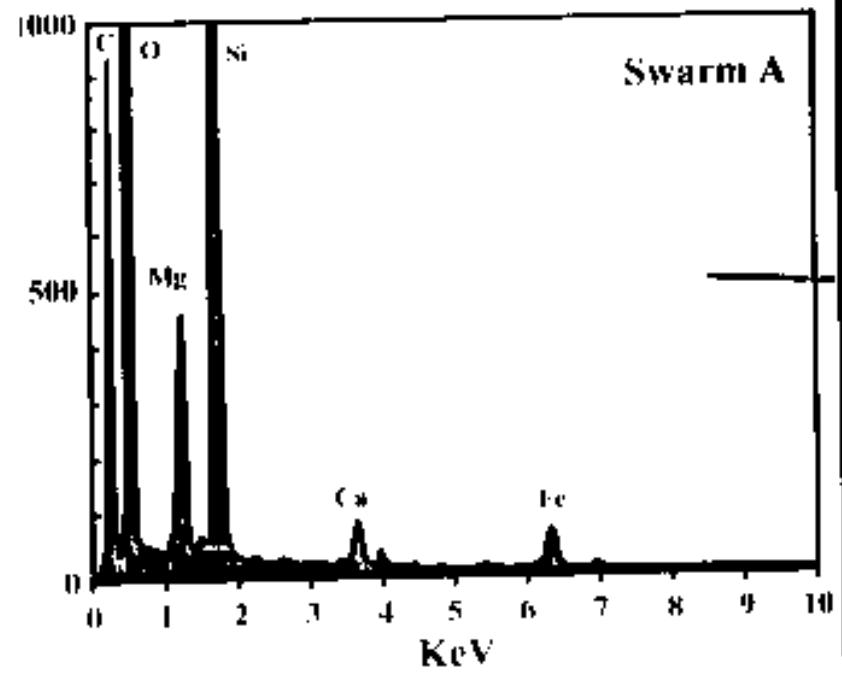
Field of view ~ 11 mm



Swarm 1







TENTATIVE CONCLUSIONS:

Man Made Particles include

Space Craft Components: Steel, Aluminum, Paints,

Operational Debris : Al_2O_3 and Diverse Waste Products

Natural Particles include:

“Chondritic” components (matrix) and Mineral Fragments

Track Morphologies Suggest:

No unique, systematic relationship between track length and particle size

No unique, systematic depth/diameter relationship of “pit-craters”

Both imply highly variable impact velocities and/or particle densities

“Calibration” of aerogel is needed, yet difficult to accomplish (scaling?)

The “swarm” event is caused by a fragmented micro-meteoroid

Analysis and interpretation of aerogel collectors are very challenging

Unsurpassed for compositional and mineralogic information

Dynamic information seems very limited (V ; D_o ; m_o)

Active trajectory sensors should be combined with passive collectors